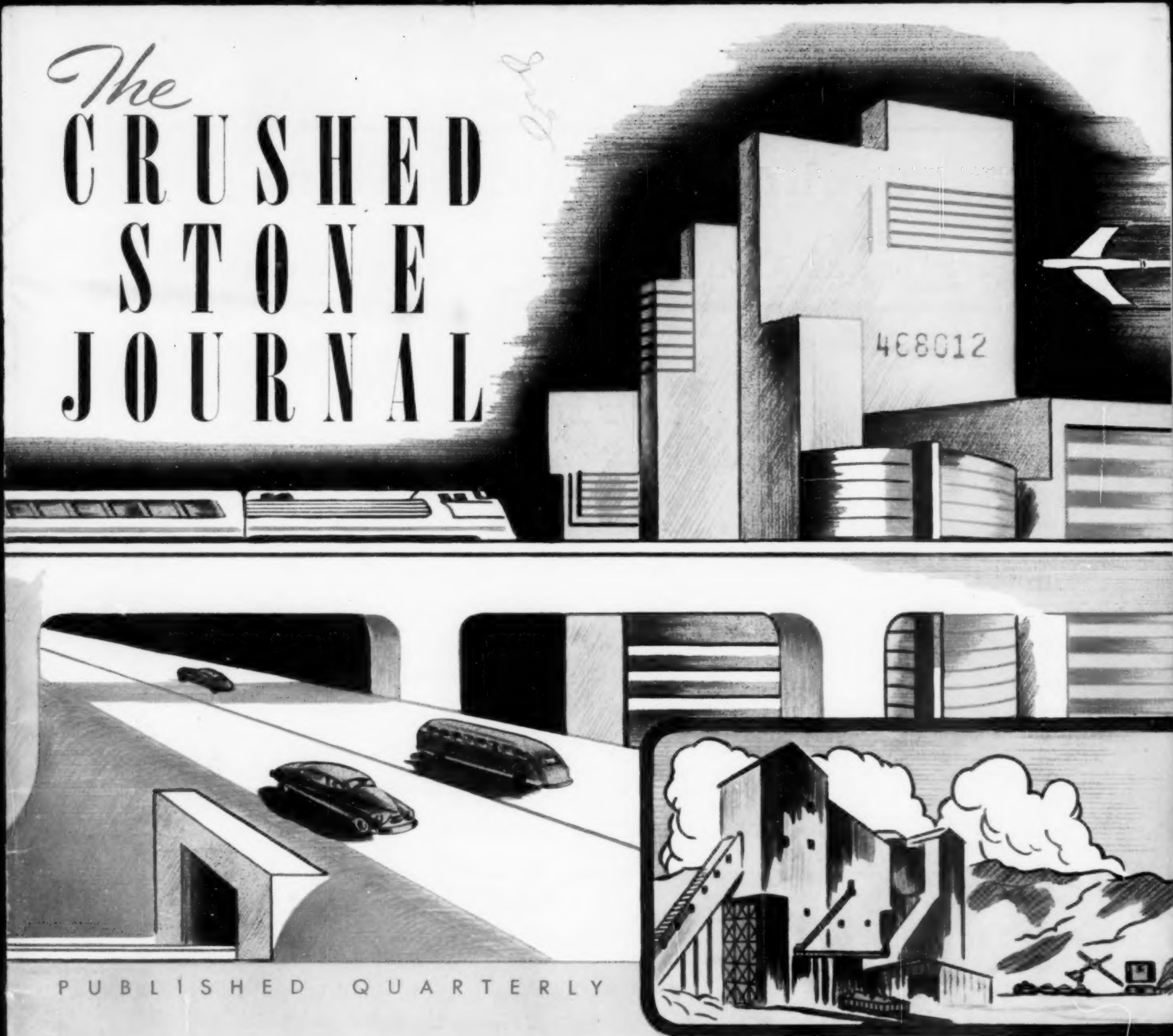
The CRUSHED STONE JOURNAL



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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
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CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XXXII No. 4 PUBLISHED QUARTERLY DECEMBER 1957

41st Annual Convention Program Nears Completion—Exposition a Sell-out

THE advantages of attending the 41st Annual Convention and Manufacturers Division Exposition of the National Crushed Stone Association February 17, 18, 19, 1958, are many and varied. No stone producer can afford to miss the helpful and valuable contacts that can be established, the informal discussions of new methods and techniques, and the factual and timely information to be derived from the various sessions.

The "Windy City" long recognized for its strategic location as a Convention city will again be host to NCSA. Headquarters will be the Conrad Hilton, one of the largest hotels in the world and one of the few capable of housing under one roof both the Convention and the Manufacturers Division Exposition.

Convention dates are rapidly approaching. Reports from the Conrad Hilton and daily inquiries to the offices of NCSA indicate that to be assured of the accommodations desired it is important that reservations be made now if you have not already done so.

In the very near future advance registration cards will be mailed to you to assist in further eliminating last minute details. By returning this card promptly to NCSA your Convention badge will be ready and waiting for you upon arrival at the Hilton. Shortly you will also have an opportunity to purchase *in advance* tickets for the luncheons and reserved seats for the social functions on Monday and Wednesday evenings.

Special Session for Operating Men

An enthusiastic and representative committee of operating men have developed a program for the Operating Men's Session which promises to be of great value to production men. Montagu Hankin, Jr., Executive Vice President, Houdaille Construction Materials, Inc., will preside over the session. A wide variety of subjects dealing with operating problems will be covered.

T. C. Cooke, President, Lynn Sand and Stone Company, will explain how "Quarry Efficiency Standard Record Keeping" can be used to reduce costs. M. J. Kilpatrick, Engineer, United States Bureau of Public Roads, has made extensive studies on various aspects of quarry work and will report the results of his findings in a talk entitled "Studies on the Efficiency of Quarry Operations."

An exceptional color film "Knowing's Not Enough," available through the courtesy of the United States Steel Corporation, will be shown during this session. This remarkable movie dealing with accident prevention will long be remembered for its message and the dramatic manner of presentation.

Of late there have been many new developments in plant design for the crushed stone industry. To keep you abreast of these developments, R. T. Lassiter, New York District Manager for Western-Knapp Engineering Company, will discuss "Recent Trends in Plant Design." Mr. Lassiter is a nationally known authority on the subject and will give an intensely interesting discussion based on his years of personal experience.

Suggestions proven by trial that save time, dollars, and manpower, will be related during "Timely Tips on Operating Problems." These tips, covering many operating problems, will help you get the job done faster and easier.

Policy Makers Round Table

Federal regulations affecting the crushed stone industry will be discussed by John F. Lane of Gall, Lane and Howe, General Counsel for the National Crushed Stone Association. Well versed in the legal problems of the industry, Mr. Lane will lead an in-

formal round table for company policy makers and advisors dealing with these regulations. Take advantage of this opportunity to explore with others under the guidance of counsel your legal problems which may have widespread significance to the industry.

Manufacturers Division Exposition

The Manufacturers Division Exposition will be the largest ever held. Close to ninety manufacturers of machinery and equipment used in the crushed stone industry will have on display their latest developments for your inspection. Technical representatives of exhibiting companies will be on hand throughout the Convention period to advise and consult with you on any individual operating problems. Monday afternoon and Wednesday morning have been specifically set aside on the Convention program for viewing the exhibits free from conflict with other Convention activities. Scheduling in this manner provides ample opportunity for a leisurely inspection of the Show without missing any of the sessions.

General Program Highlights

The Convention Arrangements Committee, under the chairmanship of O. E. Benson, President, General Crushed Stone Company, spent many hours in developing a well balanced, practical program certain to prove of real value to all. Pending the full release of all details, the following short resumé will indicate the scope of the program for the 41st Annual Convention.

Public relations cannot be practiced on a now and then basis. A company either has a well thought out and implemented program or it is missing an aspect of ever increasing importance to the best interests of its business. E. P. Holwadel, Vice President, Ohio Gravel Company, has been outstandingly successful in developing for his company an effective public relations program. Many communities are enacting zoning laws and taking other steps which tend to restrict the activities of the aggregate producer. In view of this, Mr. Holwadel's talk on Wednesday afternoon entitled "An Effective Public Relations Program for an Aggregate Producer," should stimulate thought and prove of great value.

Frank Lovejoy, who for 25 years was with Socony Mobil Oil Company's Marketing Division, has spent a lifetime in sales and marketing. Mr. Lovejoy's popularity as a speaker has been attributed to the fact that he has always considered himself a practical salesman who believes that persons in every walk of life need to know the basic principles of merchandising. His address is certain to leave a favorable and lasting impression.

The Greeting Luncheon, traditionally held the first day of the Convention, will be the setting for the presentation of awards to the winners of the National Crushed Stone Association Safety Contest. H. H. Kirwin, Chairman of the NCSA Accident Prevention Committee, and Treasurer of Eastern Rock Products, Inc., will confer the awards on the winners of the 1956 Contest. "Laughter vs. Slaughter" to L. E. Throgmorton, Vice President and Director of Public Relations for Republic National Life Insurance Company, has strange and mysterious meanings. As guest speaker at the Greeting Luncheon he will share these with us, and we can assure you that at the conclusion of his observations you will be glad you were there.

Charles Bury, Tuesday afternoon's guest speaker, is well qualified to talk on "Telephone Techniques." A communications consultant to some of America's largest corporations, Mr. Bury makes a unique presentation using demonstrations, skits, and case histories to bring out rules to follow. He has the knack of telling you, so convincingly that it is not forgotten, ways to promote your company's business through more effective use of the telephone.

Wednesday's General Luncheon will feature Jack Raymond, New York Times Correspondent, and currently with the New York Times Washington News Bureau. Mr. Raymond is a veteran of ten years of foreign reporting, most of which has been in Germany and the Soviet Union. Few men have had the experience and background of Mr. Raymond. His fascinating impressions and analytical conclusions, obtained from living and working with the Russians for some six years, will take on special meaning when you hear him speak on "The Soviet Union and Eastern Europe."

Harold Allen, Chief of the Division of Tests, United States Bureau of Public Roads, will discuss "Aggregates for Federal-Aid Roads," on Wednesday afternoon. There are few areas of interest of more importance to crushed stone producers at this time than the one Mr. Allen works with every day. It is essential that quarry operators be alert to and be informed on current specifications for aggregates for the federal-aid highway program. Mr. Allen's training, experience, and position make him a source of authoritative knowledge.

(Continued on Page 19)

Construction and Inspection Practices on Graded Aggregate Base Course in the Middle West

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Introduction

GRADED aggregate base courses as discussed in this article have been constructed in the middle west for more than twenty years. Since they have been so successful, the use of this type of base has spread to parts of the east in recent years and is gaining in popularity. For this reason, it is considered desirable to review the construction and inspection practices which have been developed over the years and have proven successful.

Graded aggregate bases have been variously defined in specifications, but are essentially an intimate mixture of uniformly graded material, containing a full range of particles from coarse to fine. Their gradation is controlled and these controls are generally specified on four or more sieves. The top size is usually 1 1/2 to 2 in. and the material grades down through minus 200 mesh material.

Quality requirements for stone in this type of base course are usually quite similar and will vary only slightly from state to state. In addition to gradation requirements, quality controls are generally as follows:

Los Angeles Abrasion Loss	Less than 50 per cent
Liquid Limit (LL)	Less than 25 per cent
Plasticity Index (PI)	Less than 6 per cent

The per cent passing a No. 200 sieve should not exceed 2/3 of the per cent passing the No. 40 sieve.

The present trend in specifications is toward a smaller percentage of fines than in the past, permitting less material to pass the No. 40 and No. 200 sieves, and requiring low plasticity. This is evidenced by the Kansas Turnpike requirements shown in Table I. It is also evidenced by the fact that Iowa, for example, has recently changed the allowable per cent passing the No. 200 sieve to 8 to 18 per cent from the formerly allowable 9 to 22 per cent. A few years ago many states permitted as much as 25 to 30 per cent of the material to pass the No. 200 sieve. Table I shows several current examples of typical base course requirements.

TABLE I
Typical Examples of Requirements for Graded Aggregate Base Material

Agency	Kansas	Iowa	Missouri	Kansas Turnpike	Ohio
Sieve Size	Total per cent passing				
2 in.	100	—	—	100	100
1 1/2 in.	95-100	100	100	70-100	—
1 in.	—	—	85-100	60-100	—
3/4 in.	70-95	75-100	—	—	60-100
1/2 in.	—	—	55-75	—	—
3/8 in.	—	—	—	39-95	45-85
No. 4	40-65	40-75	35-55	25-75	35-70
No. 10	30-55	—	—	17-55	25-50
No. 40	16-40	15-35	10-25	8-30	12-30
No. 200	8-20	8-18	—	0-12	5-15
LL (max.)	30	25	25	25	30
PI (max.)	2-8	8	6	5	6

Graded aggregate bases have generally given excellent service where there has been adequate thickness. Where failures have occurred, and thicknesses have been considered adequate, the failures have usually been attributable to the softening effect of an excess of moisture. This softening effect has often been found in bases where there have been appreciable quantities of fines, and more particularly where the minus 200 mesh material is largely silt and clay. Evidence is accumulating that softening usually will not occur if the per cent passing the 200 mesh sieve is limited to less than 10 or 12 per cent, and the PI held to 5 or less.

In frost areas failures may also occur when the fines are present in sufficient quantity and of a size distribution to permit the formation of ice lenses and consequent frost heave. This latter fact is also supported by C. H. McDonald of the Bureau of Public Roads, and reported in the Highway Research

Board Proceedings of 1949, who found that softening occurred as the result of freezing in the presence of moisture when the minus 200 mesh material exceeded 10 per cent.

Production Methods

Opportunity was recently afforded to discuss and observe, with several engineers and superintendents, crushed stone base course construction and inspection practices in the middle west. Base course materials are produced in both stationary and portable plants. In some instances the graded material is the entire crusher run product of a plant, and in other cases the required gradation is obtained by the blending or mixing of sized materials and crusher or soil fines.

There are several essentials required of the material aside from the usual quality requirements. It should be a homogeneous mixture which can be compacted on the road to a dense, strong base. This calls for a material which does not segregate. It has been found that a well graded material, if mixed with water before hauling to the road, will meet these requirements.

FIGURE 1
Mixing Unit Discharging Into Truck

For this reason mixing plants have gained extensive popularity, and on large projects several of the states are now requiring that the material be processed through a mixer. This processing consists of combining the aggregate and water in an intimate, homogeneous mixture using a pug mill or other type mixer.

FIGURE 2
Placing Second Lift of Base

The equipment used at the plant frequently consists of one or more loading bins which feed the aggregate onto a conveyor, the conveyor discharging into a mixer located at the upper end. The mixer or pug mill is equipped with spray bars or nozzles for adding water to the material as it enters. The spray bars are fed by a pump through a pipe line which usually has two valves, one of which is a metering valve and the other a quick cut-off valve which is used to start and stop the flow of water from the spray bars. Two types of mixers are commonly used. One is the single shaft bottom discharge mill in which the material is fed into the top of the mixer and over the spray bars. It is allowed to fall against the rotating blades which throw the material upwards and toward the outer side of the mill. From there the material feeds through the bottom of the mill into a truck. This type is usually shop-made by the stone producer. The other type is the conventional pug mill which gives more thorough mixing and better results.

Figure 1 shows a typical single shaft mixer at the end of a conveyor discharging into a truck. The water is sprayed into the mixer at the end of the conveyor. The conveyor, mixer, and water are all controlled by one operator and the controls are

synchronized so that the water, mixer, and conveyor can all be stopped or started simultaneously.

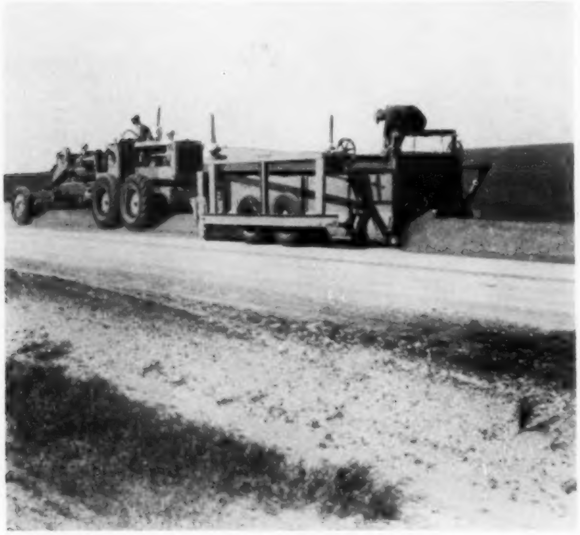

FIGURE 3
Equalizing Base Course With Shop-Built Windrow Evener

In the pug mill type mixer, it is important in obtaining a uniform moisture content that the spray bar be designed and maintained so that no dripping occurs; otherwise, the material in the mixer will become too wet while waiting for the next truck and a soft spot will result on the road. For best results, the mixer and belts should also be kept full. Regardless of the type of mixer, the water line should be so constructed that it does not drain when cut off so that when loading is resumed water is instantly available at the nozzles to maintain the water content uniform.

Laying the Base

The most frequently used method of laying the base in the middle west is still by means of a combination of motor graders and rollers; however, the use of mechanical spreaders and vibrating compactors is gaining in popularity on the larger projects.

In the blade laying method the material is weighed, hauled to the road, and dumped on the prepared subgrade. The number of lineal feet that a load of material will cover or construct is computed and staked or measured on the road by the inspector. This load distance or "spread" is computed from the weight of the material in the truck, the width and thickness of the course being placed, and the maximum wet weight per cubic foot of the material determined in the Proctor Density Test. The thickness which can be placed in one operation is usually limited by specifications to between 3 and 6 in.

Figure 2 shows a load being dumped or "spread" to a measured distance controlled by the inspector on the right. Using the tape near the right shoulder, he has computed the load distance from the driver's weight ticket. Material for a 6 in. layer is being dumped on top of a completed 6 in. layer of base.

The base is generally constructed in sections of a length that can be laid or spread and compacted in one day by the equipment available. On an average job this is about one mile if a 3 in. layer is being constructed, and about half a mile when the layer is 6 in. thick. After the material has been dumped on the section selected for spreading or "lay-down," the piles are broken down and bladed into a windrow, using a motor grader to assure uniform distribution of the material. This is called "equalizing" or "evening."

FIGURE 4
Base Being Spread and Compacted

Many contractors have constructed "windrow eveners" in their own shops for performing this operation for use on base course. Figure 3 shows a "windrow evener" which is pulled by motor graders,

being used on a project in Kansas. The gate at the rear of the evener box can be raised or lowered mechanically to adjust it to the size of windrow.

After the material has been equalized, it is "laid." This is accomplished by one or more graders blading out a portion of the material from the windrow and spreading it in thin lifts of about 1 1/2 in. loose thickness for the entire width of the base. The rollers start compaction immediately following the spreading of the material so that there is no loss of moisture. The compacted thickness of this layer is about 1 in. This procedure of grading and rolling in thin layers is repeated until the entire windrow has been laid. When the full layer of 3 or 6 in. has been spread, rolling is continued until the desired density has been obtained. Several types of rollers have been used successfully; however, the multiple wheel, pneumatic roller is the most common. One advantage of this blade laying method is that the base is compacted from the bottom up.

In Figure 4 a motor grader has spread a part of the base, followed by a Kompactor roller. A typical field test obtained from the inspector at the plant furnishing material being laid in Figure 4 on Route 100 in Iowa is given in Table II.

FIGURE 5
Finishing Base Course

Motor grader operators in the middle west are highly skilled in this type of work. Figure 5 shows an operator in the process of finishing the final surface of a base.

FIGURE 6
Completed 8 in. Rolled Stone Base Course

TABLE II

Sieve Size	Per Cent Passing
1 1/2 in.	100
1 in.	100
3/4 in.	83
No. 4	40
No. 40	16
No. 100	12
No. 200	10
LL = 23	
PI = 4	

A water distributor is also required on this type of construction in order that the base course material can be maintained at or near the optimum moisture content. In hot dry weather considerable drying out may occur during the process of final finishing and compacting. If the moisture content is not maintained near optimum the required compaction cannot be obtained. Rolling is continued on the final surface, in combination with occasional watering from the water distributor if required, until the specified density is secured. The final surface finish may be satisfactorily obtained with either a pneumatic or smooth steel roller.

Figures 6 and 7 show completed bases laid by motor grader. Note the smooth, even cross section and grade obtained by the skilled operators. Tolerances of 1/4 or 1/2 in. in 10 ft are required in the finished base course and are secured.

Inspection

On several of the jobs observed, the specifications required that the base material be delivered to the road at a moisture content between 85 and 105 per cent of the optimum moisture. This will normally permit compaction to the maximum density as determined by the Proctor Density Test. Some specifications control this moisture content within even closer limits, and it is usually found that the best moisture content is just one or two points below the optimum.

FIGURE 7
Completed 12 in. Rolled Stone Base in Iowa

The moisture content and gradation are controlled within close limits for several reasons. An excess of moisture will result in a deficiency of material being hauled to the road if the load distances have been properly computed. Too much moisture will have an undesirable wetting and softening effect on the subgrade or base that has already been laid. This will also result in soft areas which cannot be compacted to maximum density until they have been dried out. When compaction to 100 per cent of Proctor Density is required, a moisture content just slightly below optimum will usually permit obtaining the best results. Insufficient water will make it impossible to secure the required density with the rollers normally used. Since the optimum moisture content depends on the gradation of the material, a non-uniform gradation would require that the water content be varied as the gradation varies. Inasmuch as this would be very difficult, the gradation has to be controlled within reasonably narrow limits so that by applying a uniform quantity of water, a uniform product is delivered. Variations in either gradation or water content will result in non-uniform compaction and unevenness. The key note, therefore, is uniformity. Once a good base is laid it should not be disturbed because any inherent cementing value within the material may be destroyed.

In the states visited, the practice is to accomplish the required control by inspection, sampling, and testing the material at the plant. The opinion is that this is where inspection will assure a uniform high quality product. The plant is the only place where both the gradation and moisture content can be controlled together. At this location the inspector and producer, whether he be the prime contractor or subcontractor, cooperate in seeing that the desired product is delivered to the road. At the plant the inspector can test the gradation and moisture content with the greatest efficiency. Here at the plant the inspector can tell the producer what changes are needed in either gradation or water content quickly, and thus maintain closer uniformity.

It has also been found that the best place for obtaining representative samples for quality and gradation requirements is at the plant. In addition, plant inspection, because of the ease of sampling, permits more frequent testing. Here exists the opportunity for taking a complete cross section of the material being furnished, from a belt, chute, bin, or mixer outlet representative of the processed material.

The maximum size of the base material controls the size of sample required under the standard methods of test. Since the maximum size of the material is usually 1 to 2 in., the sample must weigh from 50 to 90 lb, which is then quartered down for testing to 22 to 44 lb, depending on the maximum size. To obtain a representative sample of this size from any place other than the plant is extremely difficult. It is very difficult to detect unsatisfactory material if sampling and testing are not performed

before the material is laid and compacted on the road.

In discussing plant inspection with both engineers and contractors, other cogent reasons for plant inspection were advanced. One engineer stated that it is an economic waste which benefits no one if transportation is invested in material which should have been rejected at the plant. At the point of origin the inspector can assist the producer in detecting what, if anything, is wrong with the material and aid in assuring that a product of the necessary uniformity will be delivered. It was observed by another engineer that plant inspection results in economy of engineering personnel, particularly when material from one source is being hauled to several different locations on one job or to different projects. This is particularly advantageous during the present shortage of engineering personnel.

FIGURE 8
Inspectors Making Density Test

Density tests of the material compacted in place are also required to assure that compaction requirements have been met. Such a test is being made in Figure 8. The size of the hole required for the test is dependent on the maximum size of the material, the thickness of the lift being tested, and the type of testing equipment used. In the states visited, the usual practice is to make two density tests per mile. However, more frequent testing is done if indications are such that more information is required to determine that the specified density has been attained.

The states visited are noted for their high quality graded aggregate base course construction and much of their success can be attributed to the careful uniform control resulting from plant inspection, as well as from good construction methods on the part of contractors.

Facts Revealed in Highway Program

STATE construction of the interstate highway system began, on a limited scale, as a result of provisions of the Highway Act of 1952. It got its greatest impetus in the 1956 Act but it should be remembered that many millions of dollars went into the system before this law became effective. Statistics have now been gathered by the Bureau of Public Roads which include accomplishments prior as well as subsequent to the 1956 law. Stripped of early charges for preliminary engineering and rights-of-way, the total of federal and state dollars now committed to interstate highway work is approximately $990 million. This includes over $815 million in federal funds and provides for nearly 2,000 project miles of work. Those are figures for construction now under way. Actually completed are over 1,100 project miles for which over $215 million in federal and state funds have already been invested. This is a revealing story that is not told, naturally, in reports of progress dating only from June 30, 1956. The new analysis helps to throw progress of the interstate system into proper focus; shows more clearly its true impact to date. The fact that commitment of federal funds to the states jumped from $2.7 billion to $3.2 billion in the past 30 days is certainly a healthy sign of progress. Over $930 million in federal and state funds is in effect today financing preliminary engineering and the right-of-way costs for various interstate system projects. An additional $1.3 billion is obligated for contracts advertised or let; and for projects under way or completed.

The Use of Control Charts for the Crushed Stone Industry[1]

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THE interpretations that one may put on test data are dependent on the reliability of the data. If the data are meager or widely scattered our interpretations should not be the same as when we have a large amount of data or when the data are closely grouped. For example, we are confident that averages based on many data are more reliable than averages based on only a few data.

How do we express our confidence in averages? There are in general two ways. One based on personal observation and the other on the theory of probability. For instance, let us assume that a producer is supplying stone under specifications which limits the Los Angeles abrasion loss to not over 40 per cent and that the loss for his aggregate is around 38.5 per cent. However, once in a blue moon he will get a value over 40 per cent. Someone else, utilizing the theory of probability, may report that the average value was 38.5 per cent and that in ninety-five tests out of one hundred the abrasion loss would be no greater than 40 per cent. The producer now knows the risk of having his aggregate rejected. He knows that there are ninety-five chances in a hundred that his aggregate will pass the abrasion test but he must also accept the fact that there are five chances in one hundred that his aggregate will fail.

Now, how may a producer use the knowledge he has gained from repeated abrasion tests on his aggregate to insure against rejection? The chances for rejection of a single test have been established as five in one hundred or one in twenty. In this problem it can be shown that, for averages of two tests, only one such average in 98 would exceed the specification limit; the averages of three tests, one in 435; and, the averages of four tests, one in 1,950. Thus in the case of averages of four tests, the producer's risk of rejection has decreased a hundredfold for a four-fold increase in tests. I might point out that the consumer also benefits from multiple testing since he has minimized the chances of rejecting a product when he should have accepted it. But suppose the consumer, in this case the purchaser of the aggregate, made four tests and the average abrasion loss, to our surprise, exceeded the specification limit. What has happened? The producer knows that for the average of four tests the odds are 1,950 to 1 in his favor against rejection. The logical conclusion is that the odds are so great that this cannot be considered a chance happening and therefore something in the system has changed. It may have been some time since the producer ran his tests and upon retesting he finds that a large number of his tests do exceed the specification limit. Something has definitely changed and now the producer is faced with the loss of a large part of his market. What could the producer have done to avoid this?

Quality Control

There is a technique known as quality control which would have alerted the producer to a change in his product. The data which had established the average abrasion loss at 38.5 per cent would be used to establish upper and lower control limits for abrasion loss. These limits are such that the chances are 385 to 1 against a value falling outside them. These limits for our problem, based on averages of four tests, can be shown to be 38.5 ± 1.4 per cent. In other words, the chances are 385 to 1 that all the averages will fall within the range of 37.1 and 39.9 per cent so long as no change occurs in the system. We can now construct a quality control chart which will have three horizontal lines on it. The middle line will represent the average abrasion loss of 38.5 per cent while the upper and lower lines will represent the upper and lower control limits. Now it is necessary to begin a testing program at regular intervals. This could be once a week, once every two weeks or once a month depending on production. At regular intervals four independent samples would

[1] Based on a talk given before the Seventh Engineering Conference of the National Crushed Stone Association, Washington, D. C., October 14, 1957

be taken, the abrasion loss determined for each, and the average loss plotted on the control chart. As long as all such values lie within the control limits our process is said to be in "statistical control" and no changes are required.

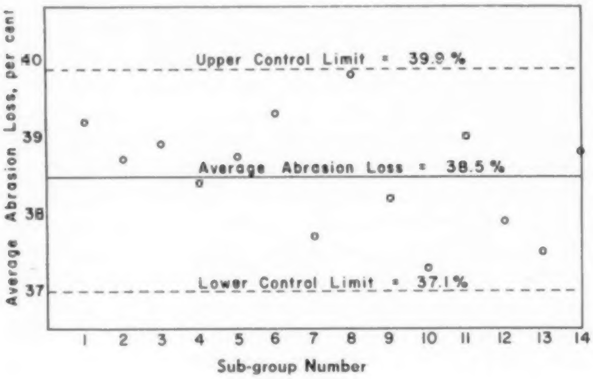

FIGURE 1
Quality Control Chart

On the other hand if a value lies outside the control limits then it is time to examine the system to see what might have changed. Once the cause for the value being outside control limits has been established decisions can be made as to what steps should be taken to reestablish statistical control. For instance, if our producer had been using a quality control chart it is likely that he would have discovered the change in the abrasion loss of his product in time to eliminate the material causing the excessive loss from his production.

Control Chart Techniques

The control chart technique is of course applicable to any process where test data are taken. The manufacturing industry has for many years used this technique to detect changes in the quality of its products. Nearly every large manufacturing concern in America today has its own quality control section headed up by a quality control engineer who reports directly to management.

The average stone producer would have no use for a quality control section but someone in the organization could be assigned the task of keeping control charts up to date. Now, one might ask, what are we going to keep control charts on. A general answer would be to keep control charts wherever our process yields a border-line or marginal product. We might use control charts to detect changes in the percentage passing a critical sieve size; the amount of material passing the No. 200 sieve; or the percentage of oversize material. Any or all of these measurements should be good indicators as to when screens or crusher jaws need to be replaced. Another important application for control charts is when new equipment is installed. During the shakedown period the product will be quite variable at first and gradually become more uniform as adjustments are made and the operators become more experienced. As data are accumulated it will become obvious from the control chart when the equipment is operating satisfactorily and no more adjustment is necessary. When that occurs permanent average and upper and lower control limits can be established. I'm sure that once a person gave some thought to the problem, many uses for control charts could be found in the crushed stone industry.

Let's review now the procedure for preparing control charts. First we need test data from which to establish the process average and the upper and lower control limits. For this purpose it would be best to collect the data into logical sub-groups preferably all containing the same number of observations.

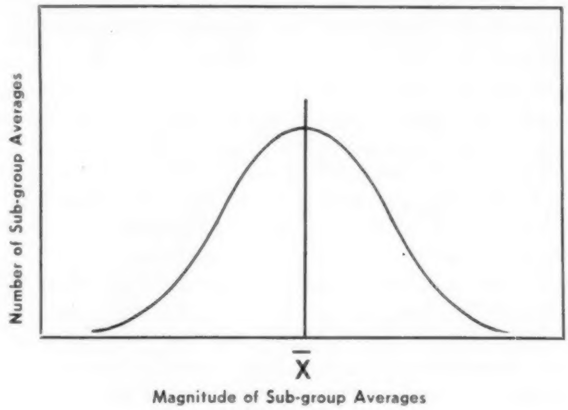

FIGURE 2
Distribution Curve

The averages of at least fifteen such sub-groups could be used to establish preliminary process average and control limit values. Final process average and control limits should be based on the averages of about fifty sub-groups.

Size of Sub-Groups

How large should each sub-group be? The answer to this question is based on the fact that if our results are going to agree with our calculated prob-

abilities our data must be distributed normally. This means that the data are distributed equally on each side of the average value with the greatest number of observations near the average and fewer and fewer observations as the values deviate from the average. The result is a bell-shaped distribution curve. It has been demonstrated that the averages for sub-groups containing four observations result in the bell-shaped distribution curve even though the distribution of the individual observations is square or triangular. Sub-groups of three are acceptable where it is known that the distribution of the individual observations is bell-shaped or nearly so. However the added assurance of four observations in each sub-group outweighs any savings that may result from only three observations when control charts are being used for the first time.

Now a decision must be made as to how and when the four observations in each sub-group are going to be made. It is important that they be made at the same time on four independent samples. It must now be decided when the samples are to be taken. Suppose we are going to sample once every two weeks. We must in some way select one day during the two-week period in such a way that each day has an equal opportunity to be chosen. There is no better way to do this than to take the required number of identical chips, balls or cubes and give each one a number representing a working day during the two week period. These are placed in a bowl and stirred thoroughly and a chip is drawn. On the day corresponding to the number on the chip the four samples are taken and the necessary tests performed. If data are obtained in this way and control charts are used there is every reason to believe that things will happen as predicted. Knowing the risks that are involved in one's predictions should in turn lead to more sound engineering and management decisions. To go a step further, once the control-chart techniques are mastered, it is not difficult to take the next step and explore the economies in production that may be possible by applying the principles of operations research.

Control Charts Have Many Uses

In conclusion, the interpretation of data can be founded on a sound mathematical basis in which the chances for error are known. Control charts, based on samples selected in a random manner at regular intervals and on sub-groups of four or more test values, appear to have many uses in the crushed stone industry as an aid to the sound interpretation of data. The use of control charts and the theory of probability should be given careful consideration by each of you. I predict you will find several important applications.

Finally, I would like to state that for a single test result no interpretation is possible. There is no way of knowing what the results of another test might show. On the other hand an average value based on four tests is likely to be a fairly reliable estimate of the over-all average, and the range between high and low values gives some idea about the variability to be expected in the test data. In other words, inferences may be drawn from a single sub-group of four tests and as these sub-groups accumulate in a regularly scheduled sampling and testing program the chances for error become smaller and one's confidence in his data grows out of all proportion to the additional effort expended in obtaining the data.

ACI Manual of Concrete Inspection

THE newest edition of the pocket-size ACI Manual of Concrete Inspection is now ready for distribution.

This 4th edition of the manual contains 240 pages of descriptive material on the inspection of concrete construction. From concrete fundamentals to the latest developments in construction, this manual covers the problems and techniques in concrete inspection, giving methods which are accepted as good practice. The manual is intended as a supplement to the usual job specifications and as a guide in matters not covered by the specifications.

This newest edition brings up to date those sections of the manual dealing with mix proportioning, winter concreting, and hot weather concreting and has been revised, editorially throughout. In particular, the first two chapters are directed to those who arrange for and direct the work of inspection.

Written and bound for use at the construction site as well as the laboratory and design office, the text, as far as possible, tells why as well as how, is brief and readable, and it interprets the policies as set forth by authorized bodies. The manual is available at $3.50 per copy from the American Concrete Institute, P.O. Box 4754, Redford Station, Detroit 19, Michigan.

Safer Blasting Through Engineering[1]

By RAYMOND H. GREEN

Safety Engineer
New Haven Trap Rock Company
New Haven, Connecticut

THE subject, "Safer Blasting Through Engineering," was chosen for two reasons: First, because the handling and use of explosives is a constant and elementary problem in quarry safety; and secondly, because the story of the success that the New Haven Trap Rock Company has had in applying the principles of engineering to the planning and execution of safer and more efficient primary blasting may be of interest to other similar operations.

There are many things that contribute to safety in the handling and use of explosives, a number of which are constantly being publicized for the benefit of the uninitiated, and as a reminder to those for whom familiarity is apt to breed carelessness. Such things as smoking in the proximity of explosives and failure to return unused dynamite or priming materials to the magazine are covered by rules in any safety minded organization, and in fact, are covered by law in most states. It should not be necessary to mention things of this nature here.

Five years ago we started to keep accurate, detailed records of all of our primary shots. This information is kept on a form (Figure 1) designed for the purpose. This form includes location, date, time, spacing and burdens, delay interval, height of face, depth of hole, tonnage of rock in front of each hole, the type and location of the various grades of explosives, and a space to note or comment on any unusual conditions.

The accuracy of many of the facts included in the record are established by accurate surveys and careful calculations. Without this engineering it would be impossible to properly analyze a blast that has already been fired, or to closely control the conditions in planning a future blast.

Surveying

A survey is made of the ledge, including adjacent areas. If the ledge is not vertical or does not slope evenly from rim to toe, a profile is taken so that it may be determined if decked charges are necessary, and how to place them.

The method used to make the survey is a simple triangulation system (Figure 2) in which the targets on the bottom and reference points on top of the ledge are located from a base line with three points out on the quarry floor. With this method practically all of the work is done out in the quarry, safely away from the ledge.

Drilling

The location of the blast holes are marked out in relation to the reference marks established by the survey. The drilling pattern used has been established by experience to be best suited to the nature of the rock in this area. When the drilling is completed the locations of the holes are checked to be certain that they were drilled exactly where they were marked.

The importance of a good drilling operation lies not only in getting the hole down to the proper depth, but getting it precisely where the engineering efforts have indicated that it should be.

Our drilling service includes a report in the form of a hole diagram (Figure 3), made by the driller, that shows all of the conditions met in the course of drilling the hole. This report includes such things as: The length of casing used, seams, caves, unusually hard rock, and where water might be running in. All of this information is valuable in planning the loading.

Loading

The physical dimensions are recorded on the loading chart, and the tonnage of rock is calculated. Then, based on the loading ratios established by the experience indicated in our records, the loading of each hole is calculated individually, and this is important, for the individual consideration of each hole is one of the most important factors in the designing of a safe, controlled primary blast. After the loading of each hole is entered on a chart, the entire area is given a visual inspection to determine if any seams or other weaknesses exist; if so, the loading is altered to accommodate the weakness. From this point on, it is a matter of proper supervision together with

[1] Based on a talk given before the Cement, Quarry and Mineral Aggregates Section of the National Safety Congress, October 22, 1957

THE NEW HAVEN TRAP ROCK CO.

DA – 4/57

PLANT NO. 1 DATE 11-1-57 DRILLING NO. 1-I-57 SHOT NO. 1-9-57
LOCATION NORTH END TIME 10:45 AM SHEET 1 OF 2

HOLE NO.		1	2	3	4	5	6	7	8
SPACING			21	24	23	25	24	23	22
DELAY		25 MS	—	26 MS	26 MS	26 MS	26 MS	26 MS	26 MS
BURDEN	RIM 13	15	30	30	30	30	31	21	21
	TOE	44	34	33	33	34	34	31	31
HEIGHT OF FACE		118	120	118	117	119	118	116	115
DEPTH OF HOLE		123	125	123	122	124	123	121	120
TONS PER HOLE		6927	8181	8278	8385	8837	8540	6435	6240
EXPLOSIVES	NITRAMEX #2H - 9x18	15-1102.5	15-1102.5	15-1102.5	15-1102.5	15-1102.5	15-1102.5	15-1102.5	15-1102.5
	NITRAMON #2-8.5x24	31-1767	33-1881	32-1824	32-1824	32-1824	32-1824	31-1767	30-1710
	" PRIMER - 9x24	4-220	4-220	4-220	4-220	4-220	4-220	4-220	4-220
	" " - 7x24	1-43	1-43	1-43	1-43	1-43	1-43	1-43	1-43
	PELLETOL #1	150 #	—	—	—	—	—	—	—
TOTAL		3282.5	3246.5	3189.5	3189.5	3189.5	3189.5	3132.5	3075.5
WATER		—	2	2	1	1	1	2	2
STEMMING		35	30	30	30	31	30	30	30.5
DECK CHARGE									
NITRAMON #2-8½x24		1	1	1	1	1	1	1	1
" PRIMER 7x24			1	1	1	1	1	1	1
" " 8x24		1							
LOCATION		32-28	24-20	24-20	24-20	24-20	24-20	24-20	24-20

REMARKS 9 SNAKE HOLES - 400 # - 60% SPECIAL GEL.

FIGURE 1
Form Used to Record Data for Primary Blasts

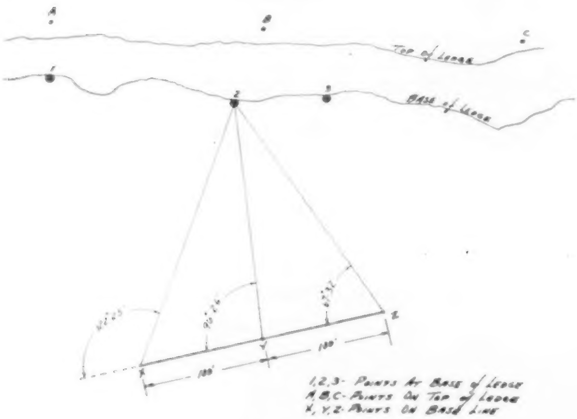

FIGURE 2
Diagram of Triangulation Scheme Used in Surveying Ledge. The Bottom Points (1, 2, 3) and Top Points (A, B, C) Are All Located Just as No. 2 Shown in Diagram

experience and in many cases some ingenuity in overcoming the problems encountered while loading blast holes.

Blasting Supplies

Another important factor in safe blasting, and one that is quite often overlooked, is the presence and the condition of blasting supplies. A good blasting machine or power source is necessary; one that has more than enough capacity to do the job; a lead wire with more than just adequate current carrying capacity and covered with a good tough insulation to withstand dragging over rough terrain. This is an item that should be tested and inspected frequently. Breaks in the insulation could ground out some of the power and cause a partial misfire. A good blasting ohmmeter is a necessity. The sum of the resistances of all of the detonating devices, con-

necting wire and lead wire should be determined and checked with a blasting ohmmeter to be certain that the circuit is complete.

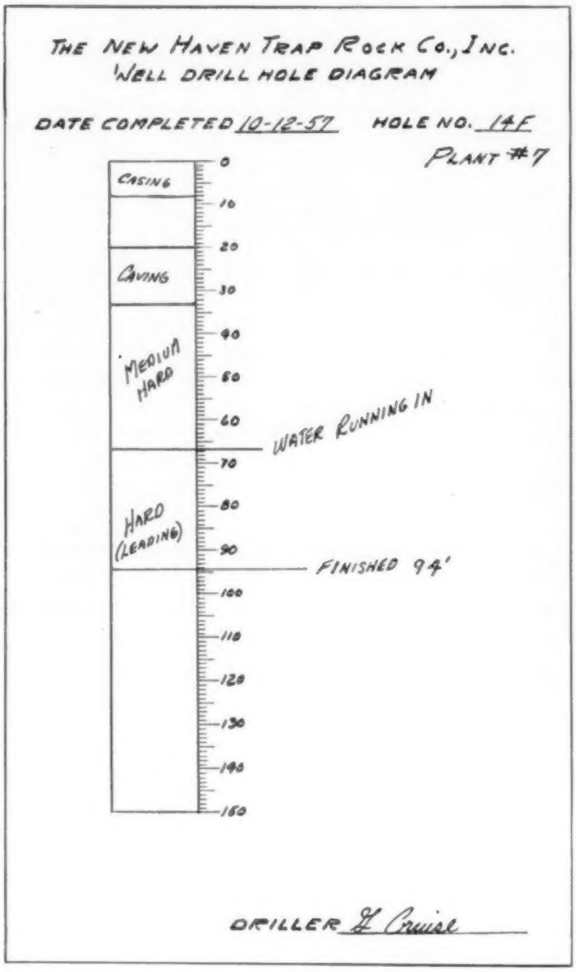

FIGURE 3

Drilling Report
Made Out by the Driller as the Hole Is Being Drilled

Importance of Safe, Efficient Methods to Production

This year has presented our company with demands upon our production far beyond that of any previous year. This is due in part to the fact that the State of Connecticut is building a throughway scheduled for completion in December 1957. To fully utilize our production facilities to meet this demand, one of the basic requirements is primary blasting that yields well broken stone in a low, yet reasonably well confined pile that is safe and easy to dig. With a background of recorded experience, and with controlled conditions these requirements were met with complete safety.

In a recent issue of "Better Blasting," a technical bulletin issued by the Atlas Powder Company, D. M. McFarland, Manager of the Atlas Technical Division, had this to say: "Blasting has become more of a science, less an art. True, it still isn't as simple as adding two and two, nor as precise. Rock formations are too unpredictable for that. But it's getting closer to perfection and precision every day, thanks to our ability to plan and control loading and initiation."

From beginning to end, from planning to execution, the important factors are: Accuracy and attention to details, large and small. If these factors are observed, and reinforced with recorded experience, it will be found that the results of primary blasts can be better anticipated, and in many cases tailored to suit the needs of the season and the type of equipment it is going to be processed in. In short, safer and more efficient primary blasting.

New Office To Handle Construction Statistics

H. B. McCOY, Administrator of the Business and Defense Services Administration, United States Department of Commerce, announced the establishment in BDSA of the Office of Construction Statistics. This new office has been assigned the responsibility of acting as the focal point in the Department of Commerce for planning, developing, and conducting the fact-finding activities on major aspects of the construction industry, such as volume, costs, materials, production, and consumption.

NCSA Seventh Engineering Conference

EXECUTIVES, salesmen, engineers, operating men, and superintendents—176 in all, attended the Seventh Engineering Conference of the National Crushed Stone Association. The Conference held in Washington, D. C. was certainly one of the highlights of the Association's many activities for 1957. With an ever increasing number of modifications, changes in specifications, and new concepts developing each year, the Conference was of real importance to producers of crushed stone.

For three days from nine to five with breaks for lunch, members of the Conference listened to and participated in discussions on all phases of the crushed stone industry. Such talks as "Testing of Aggregates," "Interpretation of Test Data," "Deleterious Materials," and "Quality of Aggregates for Federal-Aid Roads" give some idea of the subjects on Monday's program. With this background material thoroughly covered, Tuesday's session turned to "Proportioning of Concrete," "Fundamentals of Rigid Pavement Design," "Prestressed Concrete," "Materials and Proportioning for Concrete Pipe," "Admixtures for Concrete," "Importance of Adequate Shoulders," and "Solutions to Problems of Slippery Pavement." With every speaker a recognized authority in his field, there were generally many questions following each presentation. It was not uncommon to see several conferees gathered around a speaker after his address, pressing for further information. Pavement base courses are of particular importance to this industry because of the huge volume of stone required. On Wednesday a practical symposium on this subject was held, with talks on "Subbases," "Waterbound Macadam Base Construction," and "Stabilized Aggregate Base." Because of the influence on highway base design, talks on airfield construction by representatives of the U. S. Corps of Engineers proved of great interest to Conference members.

Secure in the knowledge that all remarks were "off the record" the speakers were able to express viewpoints reflecting years of background experience and training. Obviously, this made it possible for those attending to benefit greatly from this objectivity. The speakers without exception were praised for their ability to present, sometimes highly technical subjects, in a clear understandable manner to a widely diversified but keenly interested audience. It was interesting to note that many well informed engineers were enthusiastic in proclaiming the benefits derived from the Conference.

The first night a "Get-Together" party was held. This afforded producers and guests an opportunity to become better acquainted and provided a bit of relaxation from the first day's heavy schedule.

Two optional trips were planned for the day following the Conference. Some 40 men traveled by bus to the M. J. Grove Lime Company at Frederick, Maryland, to see a stabilized aggregate base mix plant in operation. This particular plant has an output of 400 tons per hour which is obtained through a rather unique design, enabling one man to operate the entire plant from the platform of the mixer. A construction project a short distance from the plant made it possible to see the construction of a base course with this mix. After having heard intensive discussions on this type of base course, the field trip was found to be a very valuable adjunct to a complete understanding of the pros and cons of this type of construction.

The Association played host to those visiting the NCSA Laboratory to view the physical testing and research activities being conducted. Much interest was evidenced during the demonstration of such tests as freezing and thawing, particle shape, and tests for slipperiness. The entire Laboratory was arranged so that it was possible to wander around and examine the various test apparatus and typical samples of materials. Altogether some 22 tests were "on display" with the Laboratory Staff available to explain the equipment and answer questions.

Representatives from active member companies were from all sections of the country. It was particularly noticeable that the size of company was no indication of participation. There were representatives from companies of every size and typifying every kind of production. The Engineering Conference affords an unique opportunity to become cognizant of the new concepts and techniques applicable to all phases of the crushed stone industry. Under the most ideal conditions and with top authorities in every field, those attending were able to ask questions and discuss individual problems and return to their jobs with better understanding and know-how.

Among Those Present at the Seventh Engineering Conference
Mayflower Hotel, Washington, D. C.

None of this, however, would have been possible without the wonderful cooperation of the speakers and the organizations which made possible their participation. Their whole-hearted assistance throughout the Conference was greatly appreciated.

Speakers on the Program

HAROLD ALLEN, *Chief*, Division of Physical Research, Bureau of Public Roads, Washington, D. C.

JOSEPH E. BELL, *Testing Engineer*, National Crushed Stone Association, Washington, D. C.

A. C. BENKELMAN, *Flexible Pavement Research Engineer*, AASHO Road Test, Ottawa, Ill.

HOWARD M. BIXBY, *Field Engineer*, National Crushed Stone Association, Washington, D. C.

J. B. BLACKBURN, *Associate Professor of Civil Engineering*, College of Engineering, University of Maryland, College Park, Md.

J. R. BOYD, *Executive Director*, National Crushed Stone Association, Washington, D. C.

EDWARD M. BRICKETT, *Engineer*, Hume Pipe of New England, Inc., Swampscott, Mass.

H. C. CRAIG, *Engineer of Construction*, Ohio Department of Highways, Columbus, Ohio

J. H. DILLARD, *Highway Research Engineer*, Virginia Council of Highway Investigation and Research, Charlottesville, Va.

ERIC L. ERICKSON, *Chief*, Bridge Design Division, Bureau of Public Roads, Washington, D. C.

A. T. GOLDBECK, *Engineering Consultant*, National Crushed Stone Association, Washington, D. C.

JOSEPH E. GRAY, *Engineering Director*, National Crushed Stone Association, Washington, D. C.

JOHN GRIFFITH, *Engineer of Research*, The Asphalt Institute, College Park, Md.

H. B. HUDSON, *Chief Field Materials Engineer*, Missouri State Highway Department, Jefferson City, Mo.

R. W. LERCH, *Soils Engineer*, Pennsylvania Department of Highways, Harrisburg, Pa.

PHILLIP L. MELVILLE, *Assistant Chief*, Soils Section, Airfields Branch, Military Construction, Office of Chief of Engineers, Washington, D. C.

C. E. PROUDLEY, *Engineer of Materials and Tests*, North Carolina State Highway and Public Works Commission, Raleigh, N. C.

JAMES M. RICE, *Research and Testing Engineer*, National Crushed Stone Association, Washington, D. C.

DONALD O. WOOLF, *Acting Chief*, Concrete Section, Physical Research Branch, Bureau of Public Roads, Washington, D. C.

41st Annual Convention Nears Completion

(Continued from Page 4)

"Threatening Road Blocks in the Highway Program" will be the title of Pyke Johnson's remarks. Mr. Johnson, as former President and now Consultant to the Automotive Safety Foundation has spent a lifetime studying America's highways. There is a growing concern as to the "lack of progress" in the federal-aid highway program. Is there really lack of progress or has there been too much optimism as to the rapidity with which the program could be carried out? From his vast knowledge of the many factors involved Mr. Johnson will analyze the current situation and the outlook for the future.

Entertainment

The first opportunity for everyone at the Convention to get together to renew acquaintances, welcome old friends, and meet new ones will be Monday evening at a gala informal dinner party full of fun and frolic.

One of the most rewarding features of NCSA conventions is the lasting friendships established and valued through the years. The Association will maintain a Social Headquarters which will be open throughout the Convention for the benefit of all in attendance. Join your friends there for relaxation whenever you find the opportunity.

To climax the convention Wednesday night's cocktail party and dinner dance will provide one last evening of good fellowship before returning home.

For the Ladies

An appealing program is being planned for the ladies. There will be a special Ladies Headquarters open throughout the Convention period where our capable and gracious member hostesses will assist all to join with others and thoroughly enjoy themselves. Indicative of the good time had by the ladies at past Conventions is the ever widening circle of those who attend. We hope this year to see more ladies in attendance than ever before.

Everyone Invited

This forthcoming Convention of NCSA is not restricted to members of the Association only. It is hoped that each and every one interested in the crushed stone industry will feel free to come and participate. Plan now to attend what promises to be the most memorable of all, the 41st Annual Convention and Exposition of the National Crushed Stone Association, February 17, 18, 19, 1958, at the Conrad Hilton Hotel, Chicago, Illinois.

Crushed and Broken Stone in 1956*

By WALLACE W. KEY
NAN C. JENSEN

Under the Supervision of G. W. Josephson, Chief, Branch of Construction and Chemical Materials, Division of Minerals, U. S. Bureau of Mines, Washington, D. C.

THE crushed stone industry established a new production record in 1956, as the Federal Highway Program initiated in midyear began to gain momentum. The 504 million short tons valued at $689 million reported by the producers to the Bureau of Mines, United States Department of the Interior, in 1956 compares with 468 million tons valued at $632 million reported in 1955.

As in previous years, the 1956 output included crushed stone used for concrete aggregate, roadstone, cement, lime, metallurgical flux, railroad ballast, refractory stone, agricultural limestone, abrasives, riprap, and in various chemical and manufacturing processes. Asphaltic stone and slate granules and flour are not included in this total. Furnace flux, railroad ballast, and some minor uses of stone decreased in tonnage but the major uses increased. The average unit value gained 2 cents per ton to $1.37.

Crushed and broken stone used for concrete aggregates and road construction reached 276 million short tons, over half of the total production. Ninety-one per cent of the output going into these two uses was produced by commercial operators.

Stone used in making portland and natural cement accounted for 17 per cent of the total in 1956, increasing 3 per cent in quantity and 2 per cent in value over 1955. Limestone furnace flux (8 per cent of the total stone production in 1956) declined 6 per cent compared with 1955. Agricultural limestone increased 8 per cent in tonnage and 9 per cent in value. Railroad ballast decreased slightly in tonnage and value.

* MINERAL MARKET REPORT MMS No. 2711, November 21, 1957

CRUSHED AND BROKEN STONE SOLD OR USED BY PRODUCERS IN THE UNITED STATES [1] 1955-56, BY PRINCIPAL USES

Use	1955			1956		
	Short Tons	Value		Short Tons	Value	
		Total	Average		Total	Average
Concrete and roadstone	[2] 254,587,585	[2] $336,259,822	$1.32	276,268,932	$369,882,572	$1.34
Railroad ballast	15,870,781	16,757,595	1.06	15,481,250	16,545,084	1.07
Portland and natural cement [3]	[2] 84,209,324	[2] 89,664,629	1.06	86,452,410	91,603,819	1.06
Furnace flux (limestone)	40,068,165	52,905,898	1.32	37,789,063	52,486,524	1.39
Agricultural limestone	18,360,040	29,455,066	1.60	19,864,045	32,087,185	1.62
Lime and dead-burned dolomite [4]	16,409,221	[2] 21,739,771	[2] 1.32	17,494,949	24,028,136	1.37
Riprap	10,285,771	13,680,155	1.33	13,133,611	15,564,796	1.19
Alkali works	5,753,468	6,280,552	1.09	5,722,924	5,965,040	1.04
Refractory [5]	1,169,330	5,777,984	4.94	1,435,950	11,054,440	7.70
Asphalt filler	1,405,477	4,366,991	3.11	1,612,940	3,592,287	2.23
Glass factories	904,491	2,626,962	2.90	987,039	2,927,888	2.97
Calcium carbide works	719,428	621,536	.86	1,245,302	1,059,660	.85
Sugar factories	661,004	1,624,636	2.46	724,923	1,750,152	2.41
Paper mills	518,381	1,208,742	2.33	518,356	1,453,778	2.80
Other uses	[2] 17,035,152	[2] 49,331,064	[2] 2.90	24,982,947	59,217,992	2.37
Total	[2] 467,957,618	[2] 632,301,403	1.35	503,714,641	689,219,353	1.37

[1] Includes Territories of the United States, possessions, and other areas administered by the United States
[2] Revised figure
[3] Limestone, cement rock, and shell
[4] Limestone, dolomite, and shell
[5] Ganister and dolomite

STONE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, 1955-56, BY STATES

State	1955		1956	
	Thousand Short Tons	Value (Thousand Dollars)	Thousand Short Tons	Value (Thousand Dollars)
Alabama	8,269	11,867	[1] 12,343	[1] 14,702
Arizona	1,601	2,329	1,623	2,474
Arkansas	6,176	8,026	6,325	8,113
California	[2] 24,708	[2] 37,164	32,583	46,109
Colorado	2,149	3,508	2,250	5,217
Connecticut	[1] 3,642	[1] 5,452	[1] 4,428	[1] 6,590
Delaware	79	227	83	232
Florida	[1] 17,028	[1] 22,966	18,779	25,183
Georgia	[1] 7,488	[1] 14,250	[1] 9,196	[1] 20,714
Idaho	1,525	1,866	1,791	2,752
Illinois	28,866	35,621	31,855	40,859
Indiana	14,124	34,680	14,700	31,575
Iowa	15,705	18,555	14,035	17,256
Kansas	[1,2] 12,482	[1,2] 15,925	[1] 13,433	[1] 15,682
Kentucky	11,934	15,579	11,553	15,324
Louisiana	[2] 3,253	[2] 4,962	4,405	6,674
Maine	1,192	2,542	942	2,238
Maryland	[1] 5,343	[1] 8,800	6,229	13,305
Massachusetts	4,128	11,381	5,442	13,753
Michigan	33,636	28,909	33,999	31,010
Minnesota	[1] 3,005	[1] 7,043	[1] 3,084	[1] 7,552
Mississippi	573	573	656	656
Missouri	[1,2] 22,369	[1,2] 29,580	24,578	33,577
Montana	1,274	1,200	1,247	1,816
Nebraska	3,081	4,177	3,063	4,142
Nevada	1,612	2,609	1,401	2,281
New Hampshire	(3)	(3)	(3)	(3)
New Jersey	[1] 8,358	[1] 17,528	9,012	20,825
New Mexico	1,573	1,547	1,268	1,272
New York	22,812	37,919	22,805	36,135
North Carolina	10,903	16,533	[1] 8,352	[1] 11,472
North Dakota	77	81	83	87
Ohio	33,273	49,841	[1] 33,418	[1] 50,947
Oklahoma	10,933	12,295	10,547	12,417
Oregon	7,742	9,418	6,098	7,890
Pennsylvania	44,438	68,918	[1] 44,913	[1] 73,831
Rhode Island	(3)	(3)	[1] 42	[1] 221
South Carolina	3,455	4,921	[1] 3,304	[1] 4,285
South Dakota	2,262	5,679	2,200	5,725
Tennessee	[1,2] 14,381	[1,2] 22,276	[1] 15,556	[1] 23,796
Texas	27,321	33,544	32,773	36,350
Utah	1,926	2,650	2,322	3,298
Vermont	582	11,061	621	11,622
Virginia	11,966	19,870	14,082	23,076
Washington	6,593	10,580	8,057	11,606
West Virginia	5,899	9,714	6,579	10,766
Wisconsin	[1] 12,180	[1] 18,843	11,126	20,402
Wyoming	1,303	2,034	1,333	2,076
Alaska	266	290	195	595
American Samoa	9	4	2	6
Canton Island	1	2	2	5
Guam	1,241	3,352	341	311
Hawaii	1,414	2,884	3,494	6,076
Johnston Island	12	32	...	...
Midway Island	...	...	203	304
Panama Canal Zone	169	239	177	230
Puerto Rico	1,784	2,516	2,076	2,556
Virgin Islands	1	5	12	32
Wake Island	1	3	22	22
Undistributed	2,374	13,925	5,193	17,266
Grand Total [4]	[2] 470,491	[2] 708,295	506,231	765,342

[1] To avoid disclosure of individual company confidential data, certain State totals are incomplete, the portion not included being combined with "Undistributed"
[2] Revised figure
[3] Figures withheld to avoid disclosure of individual company confidential data; included with "Undistributed"
[4] Includes: 1955—2,533,274 short tons of dimension stone valued at $75,993,361; 1956—2,516,764 short tons, $76,122,878

CRUSHED STONE SOLD OR USED IN THE UNITED STATES [1] IN 1956, BY METHODS OF TRANSPORTATION

Method of Transportation	Commercial Operations		Commercial and Noncommercial [2] Operations	
	Short Tons	Per cent of Total	Short Tons	Per cent of Total
Truck	237,246,246	50	270,213,889	54
Rail	90,155,041	19	90,155,041	18
Waterway	50,985,019	11	50,985,019	10
Unspecified	92,360,692	20	92,360,692	18
Total	470,746,998	100	503,714,641	100

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. Includes transportation of 117,709,902 tons of stone used in making cement and lime, and shell for various uses, as follows: By truck, 26,564,955 tons; rail, 5,788,530; waterway, 14,938,892; and unspecified methods, 70,417,525
[2] Entire output of noncommercial operations assumed to be moved by truck

Limestone and dolomite, quarried in 44 states and 2 territories, constituted 75 per cent of the total crushed and broken stone produced in 1956.

The following tables present the salient statistics of the crushed and broken stone industry for 1955 and 1956.

LIMESTONE AND DOLOMITE (CRUSHED AND BROKEN STONE) SOLD OR USED BY PRODUCERS IN THE UNITED STATES [1] 1955-56, BY USES

	1955		1956	
	Short Tons	Value	Short Tons	Value
Riprap	5,259,382	$6,422,042	7,502,708	$8,153,437
Fluxing stone	40,068,165	52,905,898	37,789,063	52,486,524
Concrete and roadstone	[2] 177,449,647	[2] 226,347,746	189,081,324	242,955,505
Railroad ballast	6,591,164	7,618,571	7,478,973	8,568,845
Agriculture	18,360,040	29,455,066	19,864,045	32,087,185
Alkali works	5,753,468	6,280,552	5,722,924	5,965,040
Calcium carbide works	719,428	621,536	1,245,302	1,059,660
Cement—Portland and natural	79,997,834	84,350,238	81,007,596	85,229,606
Coal-mine dusting	499,398	2,206,222	497,222	1,954,688
Filler (not whiting substitute):				
Asphalt	1,405,477	4,366,991	1,612,940	3,592,287
Fertilizer	449,902	850,645	405,731	817,511
Other	762,076	2,605,959	505,547	1,884,062
Filter beds	136,050	204,472	95,042	161,383
Glass factories	848,799	2,304,530	954,291	2,763,376
Lime and dead-burned dolomite	15,596,017	20,821,903	16,850,299	23,337,690
Limestone sand	741,854	924,377	2,559,888	3,432,402
Limestone whiting [3]	[2] 510,084	[2] 4,306,234	711,262	6,128,938
Magnesia works (dolomite) [4]	103,951	311,853	248,114	751,293
Mineral food	473,689	2,751,042	443,275	2,651,376
Mineral (rock) wool	19,386	46,181	11,707	17,258
Paper mills	518,381	1,208,742	518,356	1,453,778
Poultry grit	119,303	780,394	164,317	965,207
Refractory (dolomite)	287,960	461,460	266,055	446,421
Road base	889,308	1,271,684	266,577	218,291
Sugar factories	661,004	1,624,636	724,923	1,750,152
Other uses [5]	648,297	1,919,185	1,605,869	4,566,936
Use unspecified	1,471,230	1,434,257	1,208,893	1,704,033
Total	[2] 360,341,294	[2] 464,402,416	379,342,243	495,102,884

[1] Includes Hawaii and Puerto Rico
[2] Revised figure
[3] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastic, pottery, putty, roofing, rubber, toothpaste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone
[4] Includes stone for refractory magnesia
[5] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, electric products, fill material, litter and barn snow, oil-well drilling, patching plaster, rayons, rice milling, roofing granules, silicones, spalls, stucco, terrazzo, artificial stone, target sheets, and water treatment

CRUSHED AND BROKEN STONE SOLD OR USED BY PRODUCERS IN THE UNITED STATES [1] IN 1956, BY KINDS AND PRINCIPAL USES

Kind of Stone	Concrete and Roadstone		Railroad Ballast		Riprap		Agriculture	
	Short Tons	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value
Granite	22,932,395	$32,060,889	2,202,001	$2,327,563	1,137,893	$1,712,818		
Basalt [2]	32,864,326	54,289,306	1,752,171	2,423,324	1,980,996	2,167,755		
Marble	(3)	(3)					(3)	(3)
Limestone	189,081,324	242,955,505	7,478,973	8,568,845	7,502,708	8,153,437	19,864,045	$32,087,185
Shell	9,247,652	12,733,273	(3)	(3)				
Sandstone, quartz, and quartzite	7,571,505	10,707,594	859,916	1,100,631	1,233,540	2,189,381		
Miscellaneous [4]	14,571,730	17,136,005	3,188,189	2,124,721	1,278,474	1,341,405		
Total	276,268,932	369,882,572	15,481,250	16,545,084	13,133,611	15,564,796	19,864,045	32,087,185

Kind of Stone	Fluxing Stone		Refractory Stone		Other Uses		Total	
	Short Tons	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value
Granite					2,823,606	$3,950,839	29,095,895	$40,052,109
Basalt [2]					1,381,951	3,809,908	37,979,444	62,690,293
Marble					841,711	6,282,340	841,711	6,282,340
Limestone	37,789,063	$52,486,524	266,055	$446,421	117,360,075	150,404,967	379,342,243	495,102,884
Shell					10,604,355	15,634,563	19,852,007	28,367,836
Sandstone, quartz, and quartzite			1,169,895	10,608,019	1,987,839	7,376,493	12,822,695	31,982,118
Miscellaneous [4]					4,742,253	4,139,642	23,780,646	24,741,773
Total	37,789,063	52,486,524	1,435,950	11,054,440	139,741,790	191,598,752	503,714,641	689,219,353

[1] Includes Territories of the United States, possessions, and other areas administered by the United States
[2] Includes gabbro, diorite, and other dark igneous rocks commercially classified as traprock
[3] A small quantity included with "Other uses"
[4] Includes conglomerates, argillite, various light-color volcanic rocks, schists, serpentine, flint, and chats

Commissioner of Public Roads Retires

Charles D. Curtiss, Commissioner of Public Roads, is retiring December 31, 1957, after 38 years of distinguished public service with the Bureau of Public Roads of the Department of Commerce. Mr. Curtiss joined the Bureau in 1919 as Assistant to the Chief of the Bureau, rose to Chief of the Division of Control in 1927 and to Deputy Commissioner in 1943, and became Commissioner in 1955.

In 1913 he went to work for the Michigan State Highway Department, but left for a year of graduate work in highway engineering at Columbia University, where he earned a Master of Arts degree in 1915. Later that year he left the Michigan State Highway Department to join the Iowa State Highway Commission, serving there until 1917. In 1916, while working in Iowa, he earned a Civil Engineer degree from Iowa State College.

In 1927 Mr. Curtiss became Chief of the Bureau of Public Roads' Division of Control, and in 1943 he was made Deputy Commissioner for Finance and Management. In those positions he was in charge of all budget and fiscal matters, program record assembly and analysis, personnel management, equipment and procurement functions, and various other administrative services.

On January 14, 1955, Mr. Curtiss became Commissioner of Public Roads, capably heading the Bureau during the difficult period that saw the passage of the milestone-marking Federal-Aid Highway Act of 1956 and the preparation for, and launching of the huge new road-building program.

In 1951 Mr. Curtiss received the Exceptional Service Gold Medal Award of the U. S. Department of Commerce for major contributions in the administration of the federal-aid highway program and has been honored twice by Michigan State University, his alma mater, for his distinguished public service: he received the Alumnae Award in 1953, and the University Centennial Award in 1955.

Manufacturers Division
National Crushed Stone Association

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These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

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Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.
Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Air Compressors; Hauling Equipment; Engines; Tractors

American Cyanamid Co.
Explosives Department
30 Rockefeller Plaza, New York 20, N. Y.
Explosives and Blasting Supplies

American Manganese Steel Division
American Brake Shoe Co.
155 North Wacker Drive, Chicago 6, Ill.
Manganese and Alloy Steel Castings, Power Shovel Dippers, Material Handling Pumps, Reclamation and Hard-Facing Welding Materials, Automatic and Semi-Automatic Welding Machines

American Pulverizer Co.
1249 Macklind Ave., St. Louis 10, Mo.
Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing and Laboratory Sizes

American Steel & Wire Division
United States Steel Corp.
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, Ohio
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Aquadyne Corp.
89 Terminal Ave., Clark, N. J.
Dust Control Systems, Truck Bed Separating Agent

Atlas Powder Co.
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Baldwin-Lima-Hamilton Corp.
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South Main St., Lima, Ohio
Power Shovels, Draglines, Cranes, Bins, Conveyors and Idlers, Crushers and Pulverizers, Feeders, Plants—Crushing and Portable, Washing Equipment, Asphalt Plants, Dust Control Equipment, Roadpacker

Barber-Greene Co.
400 North Highland Ave., Aurora, Ill.
Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders, Asphalt Mixing Plants and Finishers, Bucket Elevators, Screens

Birdsboro-Buchanan Crusher Dept.
Birdsboro Steel Foundry and Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary and Secondary Crushers and Rolls

Boston Woven Hose & Rubber Co.
P. O. Box 1071, Boston 3, Mass.
Conveyor, Elevator, and Transmission Belts, V-Belts; Sand Blast, Water, Steam, Air, Suction Hoses

Brunner & Lay Rock Bit of Asheville, Inc.
P. O. Box 5235, Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Bucyrus-Erie Co.
South Milwaukee, Wis.
Excavating, Drilling, and Material Handling Equipment

Canadian Industries Ltd.
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Commercial Explosives and Blasting Accessories

Cape Ann Anchor & Forge Co.
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"Cape Ann" Forged Steel Drop Balls

Caterpillar Tractor Co.
Peoria 8, Ill.
Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, Diesel Electric Generating Sets, Front End Shovels, Wheel-Type Tractors

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Rex Conveyors, Elevators, Feeders, Idlers, Elevator Buckets, Drive and Conveyor Chains, Sprockets, Bearings, Pillow Blocks, Power Transmission Equipment, Portable Self-Priming Pumps, Concrete Mixers, Iron Castings

Clark Equipment Co.
Construction Machinery Division
P. O. Box 599, Benton Harbor, Mich.
Tractor Shovels; Tractor Dozers; Tractor Scrapers; Truck and Crawler Excavator-Cranes

Manufacturers Division — National Crushed Stone Association
(continued)

Continental Gin Co.
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P. O. Box 2614, Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight, and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts, Chains and Sprockets, Gears and Speed Reducers

Contractors and Engineers Magazine
470 Fourth Ave., New York 16, N. Y.
Magazine of Modern Construction

Cross Engineering Co.
P. O. Box 507, Carbondale, Pa.
Cross Perforated Steel Segments, Sections, Decks, for Vibrating, Shaking, Revolving, and Other Types of Screening Equipment

Cummins Engine Co., Inc.
Fifth and Union Sts., Columbus, Ind.
Lightweight Highspeed Diesel Engines (60-600 Hp.) for: On-Highway Trucks, Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft

Dart Truck Co.
2623 Oak St., Kansas City 8, Mo.
Off-Highway Trucks—End, Side, Bottom Dumps

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Deister Vibrating Screens, Classifiers, Washing Equipment

Detroit Diesel Engine Division
General Motors Corp.
13400 West Outer Drive, Detroit 28, Mich.
Light Weight, 2-Cycle Diesels for On- and Off-Highway Trucks; Tractors, Earthmoving and Construction Equipment; Electric Generator Sets and Industrial Power Units

Diamond Iron Works
Division Goodman Manufacturing Co.
Halsted Street & 48th Place, Chicago 9, Ill.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Drill Carrier Corp.
P.O. Box 628, Salem, Va.
"Air-Trac" Drill Carrier

Du Pont Company of Canada Limited
85 Eglinton Ave. E., Toronto, Ont., Canada
Explosives and Blasting Supplies

Du Pont, E. I., de Nemours & Co.
Wilmington 98, Del.
Explosives and Blasting Supplies

Dustex Corp.
1758 Walden Ave., Buffalo 25, N. Y.
Dust Collecting Equipment; Dust Control Systems; Feeders

Eagle Crusher Co., Inc.
900 Harding Way East, Galion, Ohio
Crushers, Pulverizers, Hammermills, 4-cage Disintegrating Mills

Eagle Iron Works
P. O. Box 934, Des Moines 4, Iowa
Fine Material Screw Washers — Classifiers — Dehydrators; Coarse Material Screw and Log Washers — Dewaterers; Water Scalping and Fine Material Settling Tanks; Drop Balls — Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders; Revolving Cutter Head Dredging Ladders

Easton Car & Construction Co.
Easton, Pa.
Off-Highway Transportation: Quarry Hauling Systems—Heavy-Duty Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving

Electric Steel Foundry Co.
2141 N. W. 25th Ave., Portland 10, Oreg., and 1017 Griggs St., Danville, Ill.
Dragline Buckets, Shovel Dippers, Bucket Teeth, Crusher Wearing Parts, Cutting Edges and End Bits

Ensign-Bickford Co.
Hopmeadow Street, Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Euclid Division
General Motors Corp.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls, Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers, Crawler Tractors

Frog, Switch & Mfg. Co.
Manganese Steel Department
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"Indian Brand" Manganese Steel Castings for all Types of Jaw, Gyratory, and Pulverizing Crushers; Dippers, Teeth, Treads, and Other Parts for Power Excavating Equipment; and Other Miscellaneous Manganese Steel Castings. Manufacturers and Fabricators of Railroad and Mine Frogs, Switches, and Crossings

Gardner-Denver Co.
South Front St., Quincy, Ill.
Portable and Stationary Compressors, Rock Drills, "Air-Tracs", Self-Propelled Drills, Sectional Drill Rods and Accessories, Air Hoists, Slusher Hoists, "Mole-Drills", Paving Breakers, Drill Steel, Gads, Etc.

General Electric Co.
1 River Road, Schenectady 5, N. Y.
Electric Motors, Controls, Locomotives, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations; Speed Reducers

Manufacturers Division – National Crushed Stone Association

(continued)

Gill Rock Drill Co., Inc.
Lebanon, Pa.
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Goodrich, B. F., Industrial Products Co.
500 South Main St., Akron, Ohio
Belting—Conveyor and V-Belts, Hose, and Industrial Rubber Products

Goodyear Tire & Rubber Co., Inc.
Akron 16, Ohio
Airfoam; Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous); Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, LifeGuard, Safety Tubes, Puncture Seal Tubes)

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Lubricating Oils, Greases, Gasoline and Diesel Fuels

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Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Wedge Wire Screens; Open Steel Floor Grating

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Explosives and Blasting Supplies

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Howe Scale Co.
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Scales. Static Weighing and Motion Weighing Devices, Automatic Batching Equipment

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Aggregate Wire Screens Made of Supertough, Abraso, and Stainless Steel Wire—Smoothtop, Longslot, Oblong Space, and Double Crimp Construction—For All Makes of Vibrators; Rubber Bucker Up Channel

Hughes Tool Co.
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Illinois Powder Mfg. Co.
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Gold Medal Explosives

Ingersoll-Rand Co.
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Rock Drills, Paving Breakers, Paving Breaker Accessories, Quarrymaster Drills, Drillmasters, Waterwell Drills, Down-Hole Drills, Carset Bits, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Pneumatic Tools, Centrifugal Pumps, Diesel and Gas Engines

Insley Manufacturing Corp.
P. O. Box 167, Indianapolis 6, Ind.
1/2 to 1 Cu. Yd. Cranes and Shovels 5 to 35 Ton Capacity with Rubber or Crawler Mounting; Crane Mountings Including Trucks, Self-Propelled Rubber-Tired Carriers and Crawlers; Concrete Buckets, Carts, and Hoppers

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Iowa Manufacturing Co.
916 16th St., N.E., Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Asphalt Plants, Stabilizer Plants, Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills, Bins

Manufacturers Division – National Crushed Stone Association

(continued)

Jaeger Machine Co.
550 West Spring St., Columbus 16, Ohio
Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers; Finishers—Concrete; Spreaders—Stone and Concrete

Jeffrey Manufacturing Co.
815 North Fourth St., Columbus 16, Ohio
Elevator Buckets; Car Pullers; Chains; Conveyors: Belt, Drag, Apron, Vibrating; Idlers; Crushers: Pulverizers; Elevators; Feeders; Pillow Blocks; Grizzlies; Screens

Johnson-March Corp.
1724 Chestnut St., Philadelphia 3, Pa.
Dust Control Engineers, Chem-Jet Dust Control Systems, Gas Scrubbers

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits; Rock and Core; Joy Microdyne Dust Collectors; Shovel Loaders

Kennedy-Van Saun Mfg. & Eng. Corp.
2 Park Ave., New York 16, N. Y.
Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel
Division of Poor & Co.
505 Kensington Ave., Chicago 28, Ill.
Oro Alloy and Manganese Steel Castings: For Shovels—Dipper Teeth, Crawler Treads, Rollers, Sprockets; For Crushers—Jaw Plates, Concaves, Mantles, Bowl Liners; For Pulverizers—Hammers, Grate Bars and Liners; For Elevators and Conveyors—Chain, Sprockets, Buckets; For Tractors—Rail Links and Grouser Plates; Drag Line Chain

King Powder Co., Inc.
P. O. Box 974, Cincinnati 1, Ohio
Detonite, Dynamites, and Blasting Supplies

Koehring
Division of Koehring Co.
3026 West Concordia Ave., Milwaukee 16, Wis.
Excavating, Hauling, and Concrete Equipment

Lecco Machinery & Engineering Co.
New Airport Road, Bluefield, W. Va.
Vibrating Screens and Vibrating Conveyors

Linde Air Products Co., Division of Union Carbide and Carbon Corp.
30 East 42nd St., New York 17, N. Y.
Oxygen, Acetylene, Welding and Jet Piercing Equipment and Supplies

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, and Power Transmission Equipment

Link-Belt Speeder Corp.
1201 Sixth St., S. W., Cedar Rapids, Iowa
Complete Line of Speed-o-Matic Power Hydraulically Controlled Cranes, Shovels, Hoes, Draglines, and Clamshells, 1/2 to 3-Yd. Capacities. Available on Crawler Base or Rubber Tire Mounting. Diesel Pile Hammers

Lippmann Engineering Works, Inc.
4603 W. Mitchell St., Milwaukee 14, Wis.
Primary and Secondary Rock Crushers and Auxiliary Equipment such as Feeders, Screens, Conveyors, Etc., Portable and Stationary Crushing and Washing Plants

Ludlow-Saylor Wire Cloth Co.
634 South Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, Steel, Stainless Steel, and All Other Commercial Alloys and Metals

Mack Trucks, Inc.
1355 West Front St., Plainfield, N. J.
On- and Off-Highway Trucks, Tractor-Trailers, Six-Wheelers, from 5 to 100 Tons Capacity, Both Gasoline- and Diesel-Powered

Manganese Steel Forge Co.
Richmond St. & Castor Ave., Phila. 34, Pa.
ROL-MAN 11.00 to 14.00 Per Cent Rolled Manganese Steel Woven and Perforated Screens, and Fabricated Parts for Aggregate Handling Equipment

Marion Power Shovel Co.
Division of Universal Marion Corp.
617 West Center St., Marion, Ohio
Power Shovels, Draglines, Cranes, Truck Cranes—From 1/2 to 75 Yd.

Marsh, E. F., Engineering Co.
4324 West Clayton Ave., St. Louis 10, Mo.
Belt Conveyors

Mayhew Supply Company, Inc.
4700 Scyene Road, Dallas 17, Texas
Blast Hole Drill Rigs

McLanahan & Stone Corp.
252 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment—Crushers, Washers, Screens, Feeders, Etc., Semi-Portable Plants

Mercer Rubber Co.
136 Mercer St., Hamilton Square, N. J.
Belting—Conveyor, Elevator, and Transmission; Hose—Air, Water, Steam, Suction, Sandblast, Miscellaneous; Rubber Chute Lining

Monsanto Chemical Co.
Inorganic Division
Lindbergh and Olive Street Road, St. Louis 24, Mo.
Prilled Ammonium Nitrate

Manufacturers Division – National Crushed Stone Association
(continued)

Murphy Diesel Co.
5317 West Burnham St., Milwaukee 14, Wis.
Engines—Industrial Engine, and Power Units for Operation on Diesel and Dual Fuel Engines. Generator Sets, AC and DC from 64 Kw. to 165 Kw. Mech-Elec Unit—Combination Mechanical and Electric Power Furnished Simultaneously

New York Rubber Corp.
100 Park Ave., New York 17, N. Y.
Conveyor Belting: Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor

Nordberg Mfg. Co.
3073 South Chase Ave., Milwaukee 7, Wis.
Symons Cone Crushers, and Symons Gyratory and Impact Crushers; Gyradisc Crushers; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens and Grizzlies; Diesel Engines and Diesel Generator Units; Mine Hoists; Railway Track Maintenance Machinery

Northern Blower Co.
6409 Barberton Ave., Cleveland 2, Ohio
Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.
135 South LaSalle St., Chicago 3, Ill.
Shovels, Cranes, Draglines, Pullshovels—Crawler and Truck Mounted

Olin Mathieson Chemical Corp.
Explosives Division
East Alton, Ill.
Explosives, Blasting Caps, Blasting Accessories

Pennsylvania Crusher Division
Bath Iron Works Corp.
323 South Matlack St., West Chester, Pa.
Single Roll Crushers, Impactors, Reversible Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyratories, Non-Clog and Standard One-Way Hammermills

Pettibone Mulliken Corp.
4710 West Division St., Chicago 51, Ill.
Tractor Shovels, Front End Loaders, Swing Loaders, Yard Cranes, Bucket and Fork Loaders, Motor Graders, Manganese Steel Castings, Material Handling Buckets, Clamshells, Draglines, Pull Shovel Dippers, Shovel Dippers, and Pumps

Pioneer Engineering
Division of Poor & Co.
3200 Como Ave., Minneapolis 14, Minn.
Jaw Crushers, Roll Crushers (Twin and Tripple), Impact Crushers, Vibrating and Revolving Screens, Feeders (Reciprocating, Apron, and Pioneer Oro Manganese Steel), Belt Conveyors, Idlers, Accessories and Trucks, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants, Mixers, Dryers and Pavers

Pit and Quarry Publications, Inc.
431 South Dearborn St., Chicago 5, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Modern Concrete, Concrete Industries Yearbook, Equipment Distributor's Digest

Productive Equipment Corp.
2926 West Lake St., Chicago 12, Ill.
Vibrating Screens

Quaker Rubber
Division of H. K. Porter Co., Inc.
Tacony and Comly Sts., Philadelphia 24, Pa.
Conveyor Belts, Hose, and Packings

Radio Corporation of America
Inspection and Control Section
Front and Cooper Sts., Bldg. 15-1
Camden 2, N. J.
Tramp Metal Detectors

Reich Bros. Mfg. Co., Inc.
1439 Ash St., Terre Haute, Ind.
Rotary and "Down-the-Hole" Drilling Machines

Rock Products and Concrete Products
79 West Monroe St., Chicago 3, Ill.

Rogers Iron Works Co.
11th & Pearl Sts., Joplin, Mo.
Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlys, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos, Underground Loaders, and Iron Castings

Schramm, Inc.
West Chester, Pa.
Air Compressors, Rotary Drills, Pneumatic Drills, Etc.

Screen Equipment Co., Inc.
40 Anderson Road, Buffalo 25, N. Y.
Seco Vibrating Screens; Scales—Industrial, Aggregates, Truck

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screens, Horizontal Screens, Simpli-Flo Screens, Tray Type Screens, Heavy Duty Scalpers, D'Watering Wheels, D'Centegrators, Vibrating Feeders, Vibrating Pan Conveyors, Car Shake-Outs, Woven Wire Screen Cloth, Grizzly Feeders

SKF Industries, Inc.
Front St. and Erie Ave.,
P. O. Box 6731, Philadelphia 32, Pa.
Anti-Friction Bearings—Self-Aligning Ball, Single Row Deep Groove Ball, Angular Contact Ball, Double Row Deep Groove Ball, Spherical Roller, Cylindrical Roller, Ball Thrust, Spherical Roller Thrust; Tapered Roller Bearings; Pillow Block and Flanged Housings—Ball and Roller

Smith Engineering Works
532 East Capitol Drive, Milwaukee 12, Wis.
Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Manufacturers Division – National Crushed Stone Association

(concluded)

Soiltest, Inc.
4711 West North Ave., Chicago 39, Ill.
Laboratory and Field Testing Apparatus: Drilling and Coring Rigs, Sieve Shakers, Sieves, Scales, Balances, Calibration Equipment, Abrasion Testing Machines, Ovens and Furnaces

Stedman Foundry & Machine Co., Inc.
P. O. Box 209, Aurora, Ind.
Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens

Stephens-Adamson Mfg. Co.
Aurora, Ill.
Belt Conveyors, Pan Conveyors, Bucket Elevators, "Amsco" Manganese Steel Pan Feeders, Vibrating Screens, Belt Conveyor Carriers, Bin Gates, Car Pullers, "Sealmaster" Ball Bearing Units, "Saco" Speed Reducers, and Complete Engineered Stone Handling Plants

Taylor-Wharton Co.
Division Harsco Corp.
High Bridge, N. J.
Manganese and Other Special Alloy Steel and Iron Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate; Elevator, Conveyor and Dredge Buckets

Thew Shovel Co.
East 28th St. and Fulton Rd., Lorain, Ohio
"Lorain" Power Shovels, Cranes, Draglines, Clamshells, Hoes, Scoop Shovels on Crawlers and Rubber-Tire Mountings: Diesel, Electric, and Gasoline, 3/8 to 2 1/2 Yd. Capacities; Thew Moto-Loader—Rubber-Tire Front End, 1 3/4 Yd. Capacity

Thor Power Tool Co.
Prudential Plaza, Chicago 1, Ill.
Wagon Drills, Rock Drills, Sump Pumps, Clay Diggers, Paving Breakers, Quarry Bars, Sinker Legs, Drifters, Rock Drilling Jumbos, Raiser Legs, Push Feed Rock Drills, Air and Electric Tools, Accessories

Torrington Co.
Bantam Bearings Division
3702 West Sample St., South Bend 21, Ind.
Anti-Friction Bearings; Self-Aligning Spherical, Tapered, Cylindrical, and Needle Roller; Roller Thrust; Ball Bearings

Tractomotive Corp.
County Line Road, Deerfield, Ill.
Rubber Tired Front-End Loaders (Tracto-Loaders)

Travel Drill Co.
P. O. Box 1124, Raleigh, N. C.
"Travel Drill"—Mobile Drill for Secondary Drilling in Quarries and Open Pit Work

Traylor Engineering & Mfg. Co.
Allentown, Pa.
Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.
17 North Seventh St., Allentown, Pa.
Explosives and Blasting Supplies

Tyler, W. S., Co.
3615 Superior Ave., N.E., Cleveland 14, Ohio
Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers, Tyler Standard Screen Scale Sieves, U. S. Sieve Series

Universal Engineering Corp.
625 C Ave., N.W., Cedar Rapids, Iowa
Jaw Crushers, Roll Crushers, TwinDual Roll Crushers, Hammermills, Impact Breakers, Pulverizers, Bins, Conveyors, Feeders, Screens, Scrubbers. Bulldog Non-Clog Moving Breaker Plate and Stationary Breaker Plate Hammermills, Center Feed Hammermills. A Complete Line of Stationary and Portable Crushing, Screening, Washing, and Loading Equipment for Rock, Gravel, Sand, and Ore. Aglime Plants. Asphalt Plants

Vibration Measurement Engineers
725 Oakton St., Evanston, Ill.
Seismographic and Airblast Measurements, Seismological Engineering, Blasting Complaint Investigations, Expert Testimony in Blasting Litigation; Nation-wide Coverage; A Complete Seismograph Rental and Record Analysis Service with "Seismolog"

Werco Steel Co.
2151 East 83rd St., Chicago 17, Ill.
Castings—Manganese, Alloy Steel; Screen Plates—Perforated Steel Screen Sections and Decks; Buckets; Chains; Belt Conveyors, Idlers; Dipper—Shovel; Drop Balls; Wire Cloth; Wire Rope and Related Products; Crushers, Pulverizers

Western-Knapp Engineering Co.
50 Church St., New York 7, N. Y.
Plant Design and Construction; Operating Studies; Appraisals

White Motor Co.
842 East 79th St., Cleveland 1, Ohio
On- and Off-Highway Trucks and Tractors—Gasoline- and Diesel-Powered; Industrial Engines—Gasoline and Diesel; Power Units, Axles, Special Machine Assemblies; Crane and Shovel Carriers; Power Generating and Distributing Systems; Batteries; All Classes of Maintenance and Repair Services

White Motor Co.
Autocar Division
Exton, Pa.
Motor Trucks

Wickwire Spencer Steel Division
Colorado Fuel and Iron Corp.
575 Madison Ave., New York 22, N. Y.
Wire Cloth, Screen Sections, Screen Plate—Perforated Steel, Wire Rope—Slings

Williams Patent Crusher & Pulverizer Co.
2701-2723 North Broadway, St. Louis 6, Mo.
Hammer Mills, Crushers, Pulverizers, Roller Mills, Reversible Impactors, Vibrating Screens, Air Separators, Bins, and Feeders